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Factsheet

GRAVITY MANURE TRANSFER SYSTEMS FOR DAIRY BARNS

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INTRODUCTION

Gravity flow is a non-mechanical way to transfer manure from the barn to long-term storage. Interest in this system is growing throughout Canada because it is simple, less expensive and, most importantly, it works.

A number of dairy farmers in Ontario, and in particular eastern Ontario, have recently installed gravity flow manure transfer systems. These usually replace worn out stackers and manure pumps. This Factsheet discusses the experiences of these farmers, the management and physical factors that are required to make it work and questions to ask yourself when considering installing such a system.

BASIC REQUIREMENTS

The most important requirement is the consistency of the manure, not the slope from barn to storage. Gravity manure transfer systems require semi-solid to liquid manure coming from the barn. If you can handle it with a fork-type loader, it's solid; with a bucket loader, it's semi-solid, and with a pump, it's liquid manure.

Experience to date indicates that you should maintain the manure as a liquid in the storage, that is, there must be enough liquid in the stored manure so that it can be mixed, pumped and transported to the field as liquid manure. In fact, manure that is semi-solid when it leaves the barn usually becomes liquid manure during storage, as long as the storage is made to hold the liquid fraction of the manure as well as precipitation (rain or snow).

WILL A GRAVITY TRANSFER SYSTEM WORK FOR YOU?

To date, 20-30 eastern Ontario dairy farmers have installed gravity manure transfer systems. Most were either ready to replace worn-out equipment (stacker, etc.), or were planning a new manure storage for economic, labor, or environmental reasons. Installation of new transfer systems, whether they are hydraulic or air-type pumps, or new stackers, is always expensive. Gravity transfer is considerably less expensive but, will it work for you?

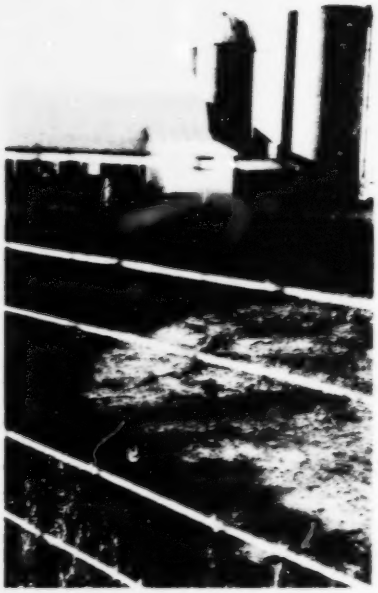

Figure 1. A typical gravity manure transfer system includes a liquid manure storage, underground drop pipe and outlet pipe, small building over drop pipe.

Ask yourself the following key questions:

- Are you having trouble containing the manure in the storage area?
- Does the pile slump, not pile at all, or ooze toward the closest stream or the neighbor's fence line, when the frost goes out in the spring?
- Do you have to add a lot of bedding in the gutter to help move manure up the old stacker?
- Do you have a high-producing dairy herd? Cattle on abundant, top-quality feed, whether it is dry hay, haylage or corn silage, tend to produce wetter manure.
- Can you construct a tank or pit 10-12 feet deep without encountering a water table or bedrock problem? A natural slope of 5-6 feet from the barn to the storage site is ideal

since this permits the storage to be built partly below and partly above grade.

If you have some slope and if the manure contains enough liquid (as determined by answering "yes" to the previous questions), then you can consider a gravity manure transfer system.

The amount of slope is important in determining what type of gravity system you choose. There are two distinct types: the minimum grade **continuous-flow system** (Figure 3), and the steep grade, **flush system** (Figure 4).

With both systems, the excavation goes to 10 -12 feet below grade in places. There is extreme danger of collapsing earth banks that could possibly bury the workmen when shaping the trench bottom and setting pipes in places. Common sense and construction codes require the use of portable "shoring", or other methods, to support the banks until the pipes are placed, aligned, sealed watertight and ready for backfilling. Hire an excavation contractor equipped to meet these important safety requirements.

THE MINIMUM GRADE, CONTINUOUS-FLOW SYSTEM

In this system, manure drops from an in-barn stable cleaner, tractor scraper or continuous-flow gutters into a vertical drop pipe. As manure is added, the head of manure in the drop pipe causes it to flow down through a transition elbow into the horizontal outlet pipe and eventually into the storage.

Mixing Normally mixing of the manure by the stable cleaner paddles or tractor blade is sufficient. With continuous-flow, avoid excessive mixing. Rather, the liquid and solid manure fractions should flow as a mass. Some farmers have added a paddle wheel, connected under the transmission of the stable cleaner and extending down into the drop pipe. Rotating slowly during operation of the stable cleaner, this seems to provide just the right amount of mixing.

Outlet Pipe Slope To encourage the manure to flow as a mass, without separation of liquids and solids, the outlet pipe should be laid with little or no slope, 0 - 1% recommended.

Size of Drop Pipe and Outlet Pipe The earliest installations used drop pipes that were sized to hold at least one day's manure production. This led to many drop pipes with diameters of 4 -5 feet. The total drop is dictated by the slope from barn to the storage, keeping in mind the slope criteria of the outlet pipe. Outlet pipe diameters have generally ranged from 24 - 36 inches, with 30 inches being most common.

Transition From Drop Pipe to Outlet Pipe It appears that the transition part may be the most important design consideration. Catch-basin type connections, where the outlet pipe is simply inserted through a hole in the side of the drop pipe, can cause problems. For example, ledges or protrusions may encourage build-up of manure. It is sometimes possible to obtain a precast concrete storm-sewer elbow.

At the least, shape the earth at the bottom of the drop pipe and use stiff concrete to make a smooth transition. The excavation should be finished by hand shovelling to conform

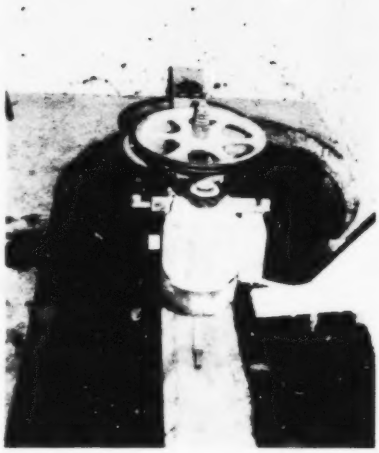

Figure 2. A stable cleaner transfers manure to the drop pipe.

to the shape of the transition in order to give good support at this location. Another option is to block a precast or plastic elbow in place and then pour concrete around the transition to fill all voids and provide support that won't shift or settle. Whether using cast-in-place concrete, precast concrete or plastic, make sure that it is smooth inside and reinforced to hold the deep earth loads which will be above it.

Since the surface elevation of the manure in the drop pipe and in the storage tend to equalize, usually within a few minutes, we are now questioning the need for a drop pipe larger than the outlet pipe. In several cases, a drop pipe the same size as the outlet pipe allowed a smoother transition elbow, improving the flow from drop pipe to outlet pipe. Therefore, in "minimum grade, continuous-flow": gravity manure systems, the best current recommendation is a uniform 30 inch diameter for the drop pipe, transition elbow and outlet pipe.

Exceptions should be made where two or more stable cleaners or a wide gutter under slotted floors must discharge into one outlet pipe. The drop pipe in these cases must have a larger opening, which dictates either a larger drop pipe or a tapered hopper at it's top.

THE STEEP GRADE, FLUSH SYSTEM

In this system, manure is held in a holding tank that is considerable higher than the storage. When the holding tank is full, a valve is opened to flush manure through the outlet pipe into the main storage. The bottom of the holding tank should be at, or above, the elevation of the top of the main storage.

Holding Tank, Valve and Outlet Pipe For practical reasons, the holding tank is sized to hold about one week's manure production. It should be 8 -10 feet deep to provide enough head to initiate the flush action through the outlet pipe when

the valve is opened. A quick-opening, guillotine-type valve is best. The valve needs to be strong enough to withstand the pressure of the liquid manure. It should slide freely in it's guides, fit closely to stop leakage and have a good linkage to the opening device. A heavy steel plate with steel "L" or "V-type" guides and a hydraulically operated opening device is recommended.

The outlet pipe can be smaller than that for the continuous flow system. One earlier system used a 16-inch outlet pipe, others up to 30 inches in diameter, but 24 inches is probably a good compromise. Either concrete or plastic pipes can be used, as long as they are smooth inside. The outlet pipe is usually connected to the holding tank via the guillotine valve located at the tank floor.

At the other end, the outlet pipe is connected into the long-term storage below, or at least halfway under, the storage floor. This ensures that the outlet is submerged as quickly as possible after emptying, thus reducing risk of freezing problems. Also, the submerged end of the pipe becomes an effective gas trap preventing gases entering the barn from the storage. It is possible to have the outlet pipe enter at the top of the main storage, but only if you are sure the pipe will drain completely and quickly after each flush. There is also a high risk of build-up of frozen manure at the outlet pipe with top entry.

GENERAL RECOMMENDATIONS

Type of Housing Systems

These gravity manure transfer systems work very well for tie-stall dairy barns with stable cleaners; or continuous-flow gutters under totally slotted heifer barns. They should work equally well in transferring manure from continuous-flow gutters under the alleys in free-stall barns or from scrapped alleys in free-stall barns. With continuous-flow gutters in the barn, more total grade from the floor level of the barn to the main storage is needed.

We have little experience with manure from cold free-stall system, but feel certain that if manure freezes on the floor and is scraped in large chunks to the drop pipe or holding tank, there will be problems.

Bedding

Management of bedding and other solid materials is of great importance. Most farmers learn quickly what they can and can't do because they want to test the system to the limit. Box stall manure can be added slowly to a big flow of liquid manure, but is would be safer to handle it as "solid" manure and move it into a separate storage.

In tie-stall barns with conventional stable cleaners, every effort should be made to keep bedding out of the gutter. With big enough stalls, bedding keepers and chopped straw or shavings, most of the bedding can be kept in the stalls, where it belongs.

What about keeping the cows' tails clean? Many farmers add considerable bedding to the gutter for this purpose alone. Properly-sized stalls help, but a number of farmers now use tail ties. This Swiss innovation prevents tails from lying in the gutter but allows the cattle freedom to switch. They also have an automatic break-away device in case a cow gets loose. Gutter grates offer another, but more expensive, way to keep the tails clean.

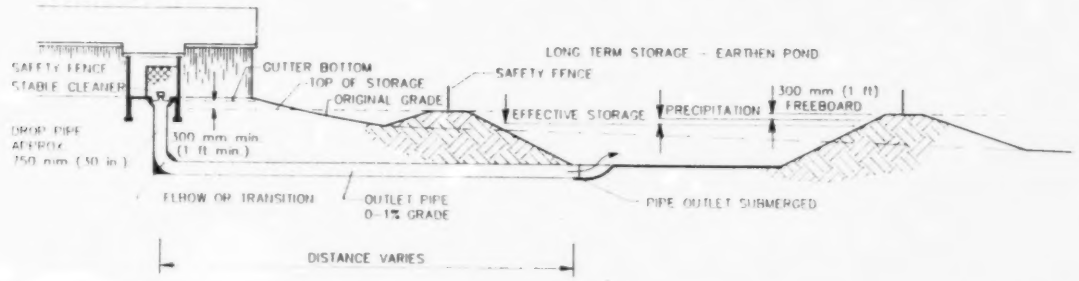

Figure 3. Minimum grade, continuous-flow system showing details of gravity transfer from a tie-stall barn.

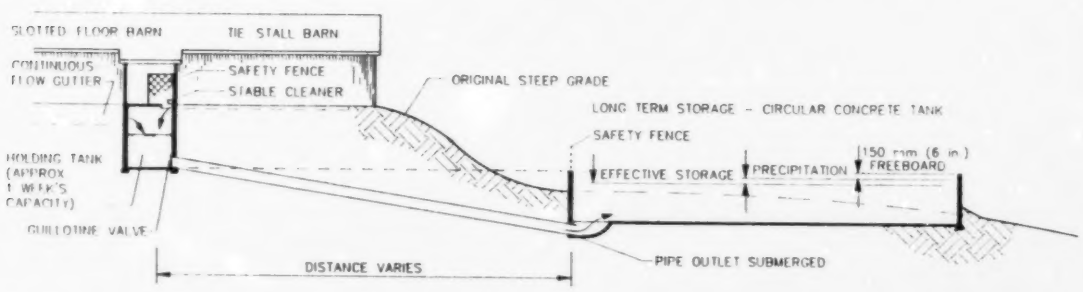

Figure 4. Steep grade, flush system showing details of simultaneous gravity transfer from two different in-bard manure handling systems.

Barns With Continuous-flow Gutters

Management here is more in line with the requirements to make manure flow in the continuous-flow gutter. If it flows in the gutter, you should have no problem with the transfer system itself. The type of feed seems to be very important, especially with heifers and dry cows where feed may be restricted. one farmer told us that with heifers on corn silage, the manure tended to be more sticky and thus didn't flow as well as when he was feeding haylage, perhaps because they drank more water with the haylage.

Adding Extra Water

Extra water helps. Many farmers dispose of their milkhouse washwater through their liquid manure systems. Usually the washwater is pumped directly from the milkhouse, overhead through the barn and into the drop pipe or holding tank. It could also flow by gravity to a storage adjacent to the drop pipe and then be transferred over by a small submersible pump.

Figure 5. A tie stall dairy barn which uses a gravity system.

Long-term Storage

In most liquid manure systems the storage should be at least 10 to 12 feet deep. Agitation equipment tends to work better at this depth and the storage collects less precipitation. With the minimum grade, continuous-flow system, strive to have the top of the storage wall 1 to 2 feet below the bottom of the deepest gutter in the barn. This will provide a minimum of one foot head to make manure flow when the storage needs emptying. To prevent a disastrous overflow, make sure the storage is sized for the longest manure production period, plus precipitation, plus 1 foot freeboard. Dimensions and capacities of various manure storages are available in other Factsheets or Canada Plan Service (CPS) plans and leaflets.

Outlet pipes up to 100 feet long should not cause any difficulty. Since the velocity of material moving through the pipe is very low, so also is the friction loss. As indicated before, experience is limited to liquid manure storages. Combination systems where liquids are drained and collected in a separate storage are questionable since the liquids are needed to keep the stored manure fluid enough to spread and fill the storage tank or pond.

Safety

Like many farm systems, there are some dangerous places which need special protection. Build a fence around the main liquid manure storage, to exclude small children and livestock. At the drop pipe opening, place a large grill of welded reinforcing bars with 8-inch square openings directly over the drop pipe. Alternatively, fence off the drop pipe or holding tank from the rest of the building with tight fencing such as corn crib wire. The gate to this area should have a lock or a latch that can't be opened by small children.

Remember as well the potential hazards of a deep excavation and the possibility of a cave-in during construction, as mentioned previously.

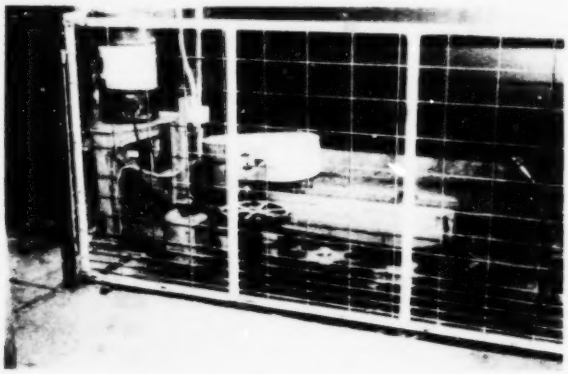

Figure 6. Stall cleaner empting into drop pipe showing a good safety fence.

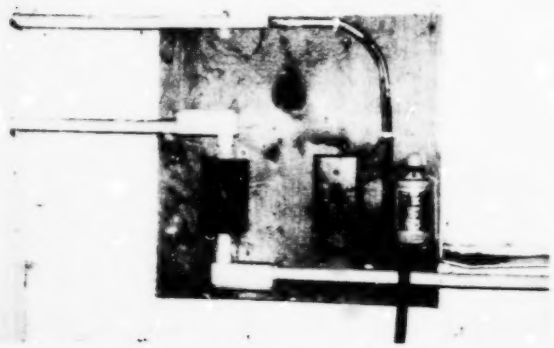

Figure 7. A control for the gullotine valve of a flush system.

CONCLUSION

Dairy farmers have constructed many variations of the gravity flow transfer systems shown. Some systems have been installed with outlet pipe slopes and diameters different from those recommended here. All of the systems seem to work quite satisfactorily. Each farmer has adapted unique management practices to suit individual systems.

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